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~~Bituminous upper layer draining blanket~~

The invention relates to a bituminous upper layer draining blanket, a method of realisation of such an upper layer blanket, as well as a carriageway comprising such an upper layer blanket.

The bituminous upper layer draining blanket, subject matter of this invention, is intended for the realisation of surface layers of stresses carriageways exposed to:

- wheel rutting,
- pollution,
- high traffic level.

Indeed, an upper layer draining blanket, in its current design, is composed of a layer of granular materials coated with a bituminous binder and applied to the required thickness.

The percentage of voids and the shape of the voids are such that rainwater may circulate in the communicating voids once this layer has been applied.

This layer is usually applied using a hooking layer onto a sub base layer when building a new carriageway or onto a surface layer in the case of maintenance. The hooking layer makes the underlying layer watertight, if the said is not already watertight intrinsically, while ensuring perfect bonding between both layers. This perfect bonding confers on both these layers a behaviour that is similar to that of a single layer.

The bituminous draining concrete layers are:

- standardised by the standard NF P 98.134 as having:
  - a voids content in the order of 20%, and
  - a percolation rate measured at the building site drainometer (NF P 98-254-3) greater than 0.4 cm/s and
- characterised in the engineering notices regarding carriageways made of special draining coated materials for company products as having
  - a voids content ranging between 20 and 25%, and

- a percolation rate measured at the building site drainometer (NF P 98-254-3) ranging between 0.8 cm/s and 1.3 cm/s.

Under the effect of the traffic, the drainage function in the bulk of this type of upper layer blanket decreases with time as a function of the ageing of the carriageway, in a variable fashion according to the product. Indeed, surface pollution is caused by rainwater in the bulk of the coated material.

The floating effect, created by the tyres, that is added to the gravitative movement of rainwater in the aggregate, repels the various polluting particles only partially.

These polluting particles are deposited, silt up and negate the draining function in the aggregate of these draining coated layers.

Surface drainability, for its own part, remains good.

The purpose of the invention is to remedy the shortcomings mentioned above and to prevent, at least, any deterioration of the draining function in the aggregate. Advantageously, the invention should enable to improve the adherence as well as to reduce the sound nuisances generated by this type of coated materials. This target must be reached under good economic conditions.

The purpose of the invention is satisfied by creating a granular differential and while promoting the horizontal and vertical draining functions in the aggregate of the coated material thanks to a suitable granular structure. This target is met under good economic conditions by using for a portion of the upper layer blanket, a modified bitumen that encloses a high proportion of road quality bitumen.

Thus, the invention relates to a bituminous upper layer draining blanket composed of two sections or partial layers, which share the improvement of the specific functions of the new upper layer blanket, i.e. improvement of the surface characteristics and improvement of the drainage and anti-rutting property.

The bituminous upper layer draining blanket comprises two partially superposed layers whereof the upper layer contains aggregate with low particle-size distribution and a modified bituminous binder, and whereof the lower layer contains aggregate with high particle-size distribution and a bituminous binder.

The partial layers are made of or treated with bituminous binders, that can be elastomer or not.

The materials and the binders are determined in relation to:

- the type of climate
- the altitude
- the stress level.

The invention also takes into account:

- the risk of wheel rutting,
- the risk of cracking by thermal shock,
- the risk associated with the slow speed of heavy vehicles and their channelled traffic,
- the risks associated with particular zones:
  (small radius curves, braking zones, parking zones, ramps).

The partial layers of the upper layer blanket are formulated so that the resultant upper layer blanket:

- is not, or little, exposed to wheel rutting,
- generates little noise,
- promotes increased microroughness in surface while preserving original macroroughness of conventional draining coated materials,
- improves significantly by its assembly the lifetime of the draining capacity of the coated materials with time.

To this end, the invention also concerns the characteristics below, considered individually or in all their technically possible combinations:

The aggregate size distribution ratio of both partial layers is approx. 3:1 to 4:1.

The aggregate size distribution of the upper partial layer is selected among the 2/4, 4/6 and 6/10 ranges.

The aggregate size distribution of the lower partial layer is selected among the 10/14, 10/20 and 14/20 ranges.

The aggregate is of monogranular type without any fines in the upper partial layer.

The aggregate is of monogranular type without any fines in the lower partial layer.

The term 'monogranular' signifies the use of a single granular class for the preparation of the material respectively of the upper or lower partial layer.

The voids content of the lower partial layer of the upper layer blanket is equal to or greater than 25%.

The percolation rate measured at the building site drainometer (NF P 98-254-3) on the upper layer blanket is equal to or greater than 3.2 cm/s.

The Hsv roughness of the upper partial layer is equal to or greater than 0.80 mm (NF P 98-216-1).

The sound attenuation of the traffic noise associated with the complex of the upper layer blanket (NF S 31-119) is equal to or greater than 3 dBA.

Either or both of the lower and upper partial layers may comprise mineral or organic additives. These additives may be for instance rock or glass fibres or waste aggregate. They are injected during the manufacture of the material in order to form the corresponding partial layer.

The modified bitumen used for the realisation of at least one of the partial layers contains at least one elastomer or polymer and a very high proportion of road quality bitumens, i.e. at least a bitumen having a significant percentage of asphaltenes. The use of such a modified bitumen enables to improve the characteristics of the products obtained and to meet the purpose of the invention under very good economic conditions.

The modified bitumen, which is advantageously used for the realisation of either, or possibly both, partial layers, is obtained in two steps whereby during the first step, a homogeneous dispersion is prepared with elastomer and bitumen selected with a low percentage in saturated products and in asphaltenes, and during the second step the dispersion is diluted with a road quality bitumen. The preferred elastomer is a styrene-butadiene-styrene based elastomer, advantageously of linear type. And the bitumen selected contains less than 6% of saturated products and less than 7% of asphaltenes and has a colloidal instability index ranging between 0.2 and 0.6. The modified bitumen

comprises, in weight, at least 30%, advantageously more than 50%, road quality bitumen and at least 3% elastomer.

According to various embodiments, the modified bitumen has any of the following characteristics, considered individually or in combination:

- a penetration at 25°C ranging between 40 and 200 1/10 mm, preferably between 40 and 80 1/10 mm and, according to a particular choice, 62 1/10 mm;
- a ball-ring temperature greater than 60°C, preferably above 85°C and, according to a particular choice, 95°C;
- elastic recall at 10°C greater than 90% and, according to particular choice, 97%;
- cohesion at 35°C greater than 2 J/cm² and, according to a particular choice, 2.55 J/cm²;
- cohesion at 40°C greater than 1.5 J/cm² and, according to a particular choice, 1.83 J/cm².

The formulation of the upper layer and that of the lower layer are selected so that the respective size distribution curves are continuous and that the partial layers exhibit a high void ratio, whereas this void ratio is approximately the same for both partial layers, i.e. ranging between 20 and 30, preferably between 25 and 30. It is obvious that in order to obtain, even approximately, the same void ratio in both partial layers, the formulation of the size distribution must be selected accordingly for each of the partial layers.

As regards the upper partial layer, the size distribution used ranges from 0/4 to 0/10. Advantageously, the size grading composition for a 0/10 size distribution is as follows:

smalls	0/2	2/4	4/6	6/10
3 – 11 %	0 – 30 %	10 – 60 %	5 – 25 %	20 – 40 %

Such a formulation enables to obtain for the upper layer, with the modified bitumen as a recommended binder, and with a 4 cm layer thickness, a permeability or percolation rate of approx. 3.9 cm/s.

A draining partial upper layer made of coated materials without any sands, with size distribution of for example 2/4 to 4/6 with an elastomer binder and small surface thickness, between 1.5 and 2 cm, enables to:

- ensure the surface characteristics (binding safety);
- reduce the noise level;
- ensure tyre/carriageway contact;
- strengthen surface roughness and ensure macroroughness.

As regards the lower partial layer, the size distribution used ranges from 0/2 to 0/14. Advantageously, the size grading composition for a 0/14 size distribution is as follows:

smalls	0/2	10/14
0 – 5 %	0 – 5 %	95 – 100 %

Such a formulation enables to obtain for the lower layer, with the recommended binder, i.e. a road quality bitumen, and with a 4 cm layer thickness, a permeability or percolation rate of approx. 3.9 cm/s.

For comparison purposes, the percolation rate through draining upper layer blankets realised before the invention is approx. 1.5 cm/s.

A draining partial lower layer made of coated materials with very high size distribution, for example 10/14 to 14/20 with or without an elastomer binder and a surface thickness between approx. 2.5 and 4 cm, enables to:

- negate the clogging effect of the coated material thanks to its very high drainability, which confers it longer efficiency than the draining coated materials of the standard NFP 98-134 or defined in the engineering notices on company products,
- improve the anti-rutting property of the coated material,
- increase the drainage capacity,
- promote horizontal and vertical circulation of water.

The invention also concerns a draining hot bituminous coated material intended for making up a blanket comprising aggregate and a bituminous binder modified by polymers in the sense of this invention.

Its main advantages are described above:

The bituminous coated material of the invention may exhibit any of the following technical characteristics, individually or in combination:

- the modified bituminous binder is a pure bitumen modified by a styrene-butadiene-styrene (SBS) copolymer,
- the modified bituminous binder may be of different composition according to the partial layer of the blanket,
- the recommended binder content depends on the granular class used, the possible addition of filler and the mineralogical nature of aggregate,
- the content of modified bituminous binder is equal to or greater than 3% in weight,
- the aggregate is of monogranular type without any smalls in the lower partial layer,
- the aggregate is of monogranular type without any smalls in the upper partial layer,
- the size distribution of the aggregate complies with one of the following ranges:
  - for the upper partial layer 2/4 – 4/6 – 6/10 or 0/2 – 2/4 – 4/6 – 6/10
  - for the lower partial layer 10/14 – 14/20 – 10 – 20 or 0/2 – 10/14;
- the void ratio is approximately the same for both partial layers;
- the upper partial layer has approximately the same void ratio as the lower partial layer;
- the average volume of the voids (total volume of voids divided by the number of voids) of the upper partial layer is smaller than the average volume of the voids of the lower partial layer;
- filler can be added or not; the addition of filler may prove necessary when manufacturing this coated material, if the content of natural fines of the class(es) used is insufficient. The make-up filler is a filler conventionally used in the formulation of coated materials of calcareous nature and is injected according to a percentage of approx. 1 to 5%;

- mineral or organic additives are used.

The application of a hooking and watertight (suited binder and dosage) layer enables to:

- ensure binding with the support of the layer, and
- obtain surface tightness of the former upper layer blanket.

The invention also relates to a carriageway realised with a bituminous upper layer blanket or coated material as defined previously.

The invention also concerns a method of manufacture of an upper layer blanket as defined above, whereas

a) binding both partial layers may be provided by an application machine that lays the blanket in a single pass, and

b) both partial layers may be bonded as well by two passes of the road finishing machine without any chemical binding.

Specific size distribution of the upper partial layer of the blanket ensures mechanic hooking with the lower partial layer by interpenetration of the aggregate elements of the contact surfaces during appropriate compacting.

Each portion of the coated material is compacted by smooth rolling.

The bituminous coated material according to the invention is manufactured in any coating station complying with the production of quality coated materials.

Particular tests, such as the CANTABRO test, which enables to test the weight loss of a sample piece with wear and which enables therefore to put in evidence the cohesion of the coated material, have shown the superiority of the draining coated materials used for the realisation of the upper layer blanket according to the invention with respect to a conventional draining coated material, a regards mechanical handling under traffic.

Indeed, the CANTABRO test that is defined by the Spanish standard NLT-352/86, consists in moulding cylindrical test pieces of approx. 1300 g, then in using them at a selected temperature in a Los Angeles-type rotating drum. Then the weight loss of each test piece is measured after wear. The smaller the loss, the more the coated material is considered as resistant.

Tests carried out respectively at –10°C and at +18°C have produced the following result as regards MASS LOSS:

Test temperature	Thin bituminous concrete	Conventional draining coated material	Draining coated material according to the invention
-10°C	18%	85%	18%
18°C	8%	41%	8%

The draining coated material according to the invention has a mass loss identical to that of a thin coated material and a significantly smaller loss than that of a conventional draining coated material.

Other characteristics and not limiting advantages of the invention will appear when reading the embodiment hereunder:

- Realisation of the coated material for the lower partial layer with:
  - size distribution 10/14 ≥ at 95%
  - addition of filler material through 80 µ mesh sieve ≥ at 2%
  - content of modified binder such as that known under the denomination 'COLFLEX' ≥ 3 ppc.
- Realisation of the coated material for the upper partial layer with:
  - size distribution 4/6 ≥ at 95%
  - addition of filler material through 80 µ mesh sieve ≥ at 2%
  - content of modified binder such as that known under the denomination 'COLFLEX' ≥ 4 ppc.

The temperature of realisation and of application remains similar to that of the monolithic draining coated materials with elastomer binders. It is equal to or greater than 135°C.